

Description of the larva of *Trineuragrion percostale* Ris (Odonata: Megapodagrionidae) with a key to the larvae of New Caledonian genera of Megapodagrionidae

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The larva of *Trineuragrion percostale* is described and illustrated based on an exuvia collected with the teneral female. Four more exuviae sampled without imagines are added for comparison and discussion of morphological variations. This is the first time the larva has been associated with the correct species, although the larval description was given earlier. Lieftinck included it in his analysis of New Caledonian Odonata larval fauna under the name *Caledargiolestes uniseri* (by supposition). Variations in the morphological features between Lieftinck's specimens and those reported here are discussed. The key morphological features that differentiate larva of *T. percostale* from other Megapodagrionidae in the country are indicated.

Keywords: Odonata; dragonfly; larva; Megapodagrionidae; *Trineuragrion*; New Caledonia

Introduction

The Odonata of New Caledonia are fairly well known based on faunistic and taxonomic investigations of imagines. Larvae have been understudied, however (Lieftinck, 1971, 1976; Lippitt Willey, 1955; Starmühlner, 1968; Winstanley, 1983, 1984). Lieftinck (1976) provided the only identification keys for larvae. They feature two of the endemic New Caledonian groups by including representatives of *Isosticta* and *Synthemis* genera. In the same paper, detailed larval descriptions are also provided for other endemic species, including, by supposition, *Caledargiolestes uniseri* (Ris, 1915) and other megapodagrionids. In a later study, Winstanley (1983) collected and reared larvae from New Caledonia which enabled him to correctly associate the larvae to adults for *C. uniseri* and *Synthemis miranda* Selys, 1871. *Caledargiolestes uniseri* was found to be the unique unidentified terrestrial larva originally described by Lippitt Willey (1955) and commented upon by Lieftinck (1976). Therefore the description by supposition of *C. uniseri* in Lieftinck (1976) was not of that species. Winstanley (1983) left the correct species affiliation of the latter an open issue. However, while describing the larvae by supposition, Lieftinck (1976) made a valuable remark. The final decision to relate the unknown larvae to *C. uniseri* was influenced by wing characters: "... length–breadth ratio of the wings and the shape of the pterostigma." However,

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he also emphasised that wing venation was close to that of *Trineuragrion percostale* Ris, 1915. De Marmels (2001) suggested that: “the larva of *Trineuragrion* is probably, and by exclusion, the one identified by Lieftinck (1976) as ‘*Caledargiolestes uniseries*’”. Finally, Kalkman et al. (2010b) included the larva of *T. percostale* in their analysis of the larval gills of megapodagrionids based on collected but undescribed material, deposited at the Cambridge University Museum of Zoology, UK. Currently, however, no clear description in the literature exists to unambiguously associate larvae of *T. percostale* to the imago.

Recently a teneral *T. percostale* was discovered with its exuvia from a stream in NE New Caledonia, and the larva is described and illustrated herein. A comparison is made with four other exuviae collected during the course of this study, and with the description of the larva attributed to *C. uniseries* by Lieftinck (1976). Important diagnostic features are highlighted.

Material and methods

The material was collected during the 2010 Rapid Assessment Program (RAP), Mt Panié, New Caledonia. One female imago with its exuvia was discovered in Pwé Kédivin Creek on 21 October. Both imago and exuvia were stored in 90% ethanol. Four other exuviae were sampled at the Wewec River on 15 October and identified as *T. percostale* based on the diagnostic features established in the original female exuvia. Variations in the body size and structures were also recorded.

Pictures of the female exuvia were taken with aid of Leica M125 stereomicroscope using Leica Application Suite V3.8. The drawings used in the current description were made with Adobe Photoshop CS4 Extended software from the original photos. All morphological features were traced with Wacom Bamboo MTE-450A tablet. Measurements (in mm) were made with calibrated ocular micrometer as follows: total length, dorsally from the anteriormost margin of labrum to the tip of the gills; head width, across the compound eyes; pronotum, dorsally across the corners of the shield (cf. Diagnosis below); femora, along the midline of the external surface; gills, dorsally from where attached to the abdomen to the tip (termination of central tracheal trunk); wing sheaths, longitudinally of the hind right wing. S1–S10 = abdominal segments 1 to 10.

Description

Specimens examined

An exuvia with its associated female imago, Pwé Kédivin creek crossing the road Hiéngghène-Pouébo about 10.4 km NW of Hiéngghène (20°37'57" S, 164°51'52" E; 40 m asl, 21 October 2010); four exuviae, Wewec River about 880 m downstream from the RAP-New Caledonia Refuge 2 site (20°35'30" S, 164°44'17" E; 265 m asl, 15 October 2010).

Diagnosis

General appearance and colour pattern as in Figure 1a, b. Body uniformly light-brown and covered with short hairs. Gills flat, arranged horizontally, thus typical of what are considered to be Fan megapodagrionids (Kalkman et al., 2010b).

Head

Roughly pentagonal, eyes smoothly aligned with postocular lobes and forehead. Dorsal area mostly flat, raised at the level of postocular lobes and curved slightly downwards towards labrum.

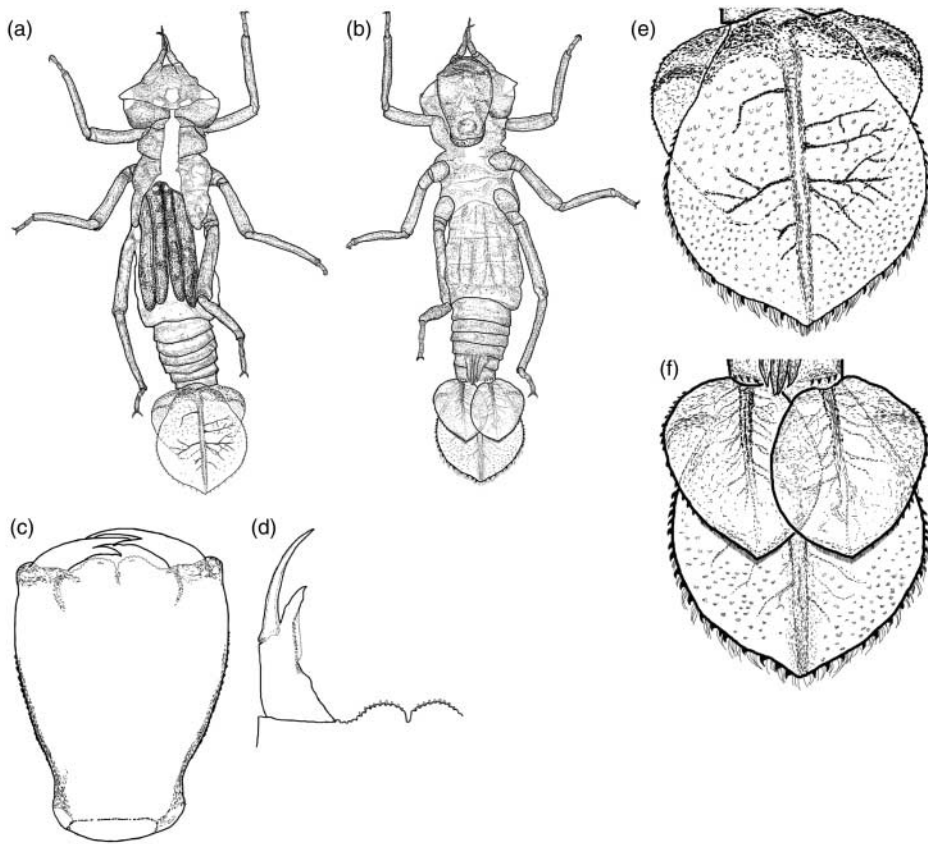


Figure 1. *Trineuragrimon percostale* exuvia – (a) dorsal view; (b) ventral view; (c) prementum; (d) labial palp; (e) gills dorsal view; (f) gills ventral view. Figures not to scale.

Group of three light spots on vertex in occipital area between eyes. Postocular lobes evenly rounded. Antenna six segmented; scape stout (width:length = 1:1.36); pedicel large, but thinner than scape (width:length = 1:2.17); segments of flagellum equal in shape, more slender than first two segments and almost the same length as scape+pedicel; short hairs densely cover first two segments. Prementum (Figure 1c) of moderate length, flat, reaching midway between first and second coxae (differences among individuals is likely); laterally with very slightly bulge at the middle, constricted proximally and ending with two well-expressed angular projections; distal end deeply incised with two serrated lobes in mid-section bearing short light seta-like tubercles in each indentation. Labial palps (Figure 1d) wide and stout, elongated distally to sharp tooth-like projection. Movable hook large and sharp pointed. Premental and labial setae absent.

Thorax

All three segments of similar length but different shape (dorsal view). Prothorax large, flat, shield-shaped; largely rounded posteriorly and nearly straight anteriorly; width anterior : posterior = 1:1.36. Mesothorax with round and smooth lateral edges. Metathorax tapering posteriorly. Legs relatively long. Femora irregularly cylindrical to dome-shaped with longitudinal mid-carina dorsally and two ribs (most pronounced on hind femora) ventrally. Tibiae slightly narrower and longer than femora with up to 4 longitudinal ribs each and short hairs developed alongside them. All

tarsi but one (middle right leg) three-segmented; two claws on all tarsi, simple with no extra teeth except on middle right leg. Hind legs surpass tip of abdomen when fully extended. Wing sheaths slightly beyond anterior end of S4 (differences among individuals is likely).

Abdomen

Relatively short, equal in length to head + thorax. S1–S4 appear laterally expanded, nearly 1.36 times wider than S5–S10 (differences among individuals is likely). S9 with one ventrolateral spine in each side (one smaller supplementary spine anteriorly on left side). S10 with 5 ventroapical spines at each side. Gills (Figure 1e, f) large and widely oval; proximal ends thicker and elevated, almost completely aligned transversely for all three gills; rest of gill surface membranous with fine spiny tubercles. Median lamella covers about 4/5 of each lateral lamella. Median lamella leaf-like and oval in shape with length:width ratio = 1:1.40; short spines developed along 3/4 of each lateral edge, becoming longer and less dense towards tip of gill; short hairs, as long as the spines, developed about half way from tip of gill and becoming twice as long as spines at distal end; central tracheal trunk very large and stout with weak branches extending perpendicularly towards lateral edges. Lateral lamellae with similar arrangements of spines, hairs and tracheal trunk with branches; they differ in having: (a) proximal elevation with immediate concavity continuing in the membranous area; (b) terminal hairs almost as long as spines, stiffer and forming brush-like tips of on gills; (c) lateral tracheal branches more numerous and leaving central trunk at an angle.

Measurements (mm)

Total length 15.3 (including gills); head width 3.3; pronotum dorsal width 2.2; femora length: fore 2, middle 2.2, hind 3.1; gills length: median lamella 4.2, lateral lamellae 2; wing sheaths length 4.

Variations

The four other exuviae (2♂♂ and 2♀♀) identified as *T. percostale* differ slightly from the description given above. Masks reaching bases of middle coxae. Wing sheaths extending to posterior end of S4 in three exuviae and to middle of S4 in one male exuvia. First four abdominal segments not expanded laterally. S5–10 covered dorsally with short hairs forming dense fringes weakly developed in S5 and S10, but going well beyond the distal ends of S6–9. One male exuvia with supplementary ventrolateral spine on one side of S8. Gills were examined in greater detail on one male exuvia only as gills were absent in the other specimens (1♂ and 1♀) or had dried out in a way that made the precise measurements impossible (1♀). Gills covered with dense, very long hairs on the elevated proximal area. Terminal hairs nearly three times as long as the spines on the tip of the gills. Although the shape of the gills of the additional female exuvia could not be examined, some other features could be compared with the larva description given above. The gill surface area appeared to be covered with a denser array of much longer hairs, predominantly on the elevated proximal part of the median lamella. Long hairs also covered the central tracheal trunk starting approximately 2/3 from the tip. Fringe hairs resembled those on the male exuvia.

Measurements: body length (without gills) 11.6–12.7; head width 3.3–3.7; pronotum dorsal width 2.1–2.7; femora length: fore 2.1–2.2, middle 2.6–2.9, hind 3.4–3.8; wing sheaths 4.2–4.6. Gills more elongated with length:width ratio = 1:1.53 (measured in median lamella only).

Habitat preferences

T. percostale is common along forest-edge streams (Davies, 2002). Marinov et al. (in press) describe it as a typical inhabitant of moderate size rivers of about 5–6 m wide, although it also occurs in wider rivers. River banks were densely vegetated with the tree canopy over 70%. Fallen tree trunks and branches in the middle course of the river were found to be of great importance for mating and ovipositing, and one was the location in which the female with the exuvia described here was found. The other four exuviae were collected on protruding boulders about 1 m from the bank in a 20 m wide, shallow rocky river.

Preliminary key to the larvae of the New Caledonian genera of Megapodagrionidae

The correct association of larva to imago of *T. percostale* completes the descriptions of the larvae of the four Megapodagrionidae genera known to inhabit New Caledonia. Larvae of two species remain undiscovered (Table 1) and make it impossible to compile a complete species identification key for the larvae. However, the available diagnostic characteristics for the four genera (summarised in Lieftinck, 1976), in combination with the distribution records and certain suppositions, may facilitate a near-precise identification. The first preliminary larvae identification key to the New Caledonian Megapodagrionidae genera is suggested below. The key is largely based on the published descriptions and figures in Lieftinck (1976) and thus requires further verification because no other larval material was checked during this study apart from what is reported above. The key is accompanied by the assumptions that one should consider when identifying the specimens at this stage of knowledge upon local Odonata fauna.

- 1. Prementum with medial incision of distal margin a rounded V-shape, not slit-like basally (Figure 2a) 2
- 1'. Prementum with medial incision of distal margin a narrow slit for much of its length, nearly closed basally (Figure 2b)..... 3
- 2. Labial palp with teeth at the tip (Figure 3a); scape and pedicel elongated with scape nearly three times as long as wide; mask reaches the bases of the first coxae *Argiolestes*

Table 1. New Caledonian species of Megapodagrionidae for which the larva is described (based on Kalkman et al., 2010b and this paper).

Species	Reference	Comment
<i>Argiolestes ochraceus</i> (Montrousier, 1864)	Lieftinck (1976)	
<i>Caledargiolestes janiceae</i> Lieftinck, 1975		No larva described
<i>Caledargiolestes uniseries</i> (Ris, 1915)	Wiley (1955), Lieftinck (1976)	For more details see Table 1 in Kalkman et al. (2010b)
<i>Caledopteryx maculata</i> Winstanley & Davies, 1982	Lieftinck (1976)	For more details see Table 1 in Kalkman et al. (2010b)
<i>Caledopteryx sarasini</i> (Ris, 1915)		No larva described
<i>Trineuragrion percostale</i> Ris, 1915	Lieftinck (1976); this paper	

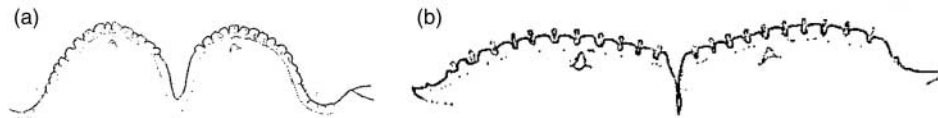


Figure 2. Comparison between the incisions of the distal part of the prementum in: (a) *Argiolestes*; and (b) *Caledargiolestes*. Drawings after Lieftinck (1976); not to scale.

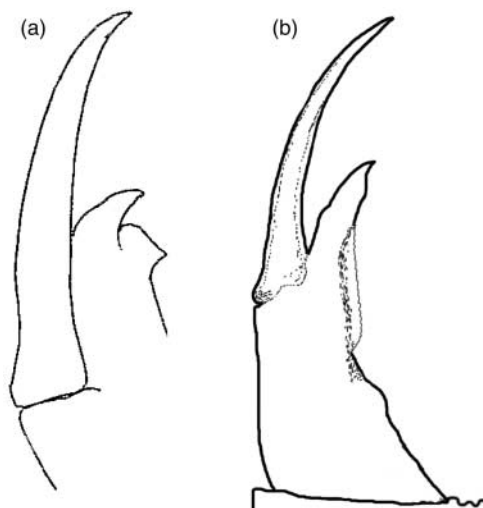


Figure 3. Comparison between the labial palps of: (a) *Argiolestes*; and (b) *Trineuragrion*. Drawings of *Argiolestes* after Liefertinck (1976), those of *Trineuragrion* original; not to scale.

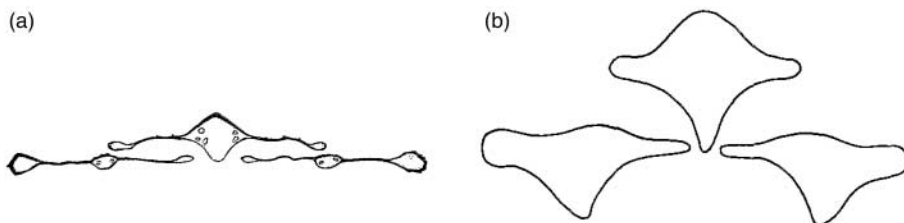


Figure 4. Comparison in cross section between the gills of: (a) *Caledopteryx*; and (b) *Caledargiolestes*. Drawings after Liefertinck (1976); not to scale.

- 2'. Labial palp without teeth at the tip (Figure 3b); scape and pedicel stout with scape less than 1.5 times as long as wide; mask reaches the bases of middle coxae *Trineuragrion*
- 3. Gills flat in cross section, only central tracheal trunk conspicuous (Figure 4a); larvae generally hairless *Caledopteryx*
- 3'. Gills swollen in cross section mostly at the central tracheal trunk, but also in the lateral expansions (Figure 4b); almost the entire larva covered in dense hairs *Caledargiolestes*

Notes on the key

Argiolestes currently includes 48 species found on New Caledonia, through much of western Melanesia, and Sulawesi and Luzon (Kalkman et al., 2010a). *A. ochraceus* (Montrousier, 1864) is the sole representative of the genus and is endemic to New Caledonia. Davies (2002) found it quite common throughout the country.

Trineuragrion is a monotypic genus, with *T. percostale* Ris, 1915 being widespread in New Caledonia (Davies, 2002) and also known from the Republic of Vanuatu (Kimmins, 1936).

Caledopteryx includes two species, both endemic to New Caledonia. *C. maculata* Winstanley & Davies, 1982 is confined to the south with its currently published distribution range as far north as the road from Boulouparis to Thio or perhaps the West to East road from Bourail to Canala (Davies, 2002). *C. sarasini* (Ris, 1915) is only reported north of that border. Liefertinck (1976)

described the supposed larva of *C. sarasini* before the description of *C. maculata*, but, according to Winstanley & Davies (1982), Lieftinck's description was based on larva discovered in a locality where at present only *C. maculata* is known. Thus Lieftinck (1976) probably described the larva of *C. maculata* (Kalkman et al., 2010b), leading to the assumption that larva of *C. sarasini* is still unknown (Table 1).

Caledargiolestes also includes only two New Caledonia endemics. The key to the genera is based on the description of the larva originally published in Lippitt Willey (1955) as an unidentified larva and redescribed in Lieftinck (1976) as "Genus et species incert". Its correct affiliation was clarified by Winstanley (1983), who claimed it as belonging to *C. uniseries* (Ris, 1915) (all commented upon in Kalkman et al., 2010b). The other species from the genus, *C. janiceae* Lieftinck, 1975, appears to be a near ally to *C. uniseries* and probably their larvae are similar. The larva of *C. janiceae* is not described yet (Table 1), but probably it will key out in *Caledargiolestes* and could be identified by supposition. *C. janiceae* is known from one locality only, Mt Pouédihi (Davies, 2002; Lieftinck, 1975), while *C. uniseries* is common and widespread (Davies, 2002).

Discussion

Although reported here as for the first time, the actual description of the larva of *T. percostale* was made earlier. Lieftinck (1976) included a description in his detailed study on New Caledonian larvae under the name *Caledargiolestes uniseries* (by supposition). His judgement was made upon three fully grown larvae which he had dissected in order to examine the wing venation (see above). However, the description of the larva agrees in most of the characters with the female *T. percostale* presented here. The identification features in full congruence (which were also found to be diagnostic for *T. percostale*) are: (a) shape of the labium and all its parts (tips of labial palps, shape of movable hook, incision of the median lobe with fine dentition and short hairs, and posterolateral corners); (b) shape of the antenna; and (c) the total body size. Although not illustrated here the mandibles presented in Lieftinck (1976, p. 176, fig. 28) are also identical with the exuvia examined during the current study. The only difference observed was in the shape and hairiness of the gills.

Lieftinck (1976)'s drawings depict a male specimen. The gills appear to be longer and to have longer hairs than the female described here. Similar characters were established in the male exuvia examined here (see Variations). Given the resemblance in other features, the disparity in the gills' characters could be attributed to sex-related differences, although at present such statement is highly speculative given the low number of exuviae examined during the study. Moreover, sex discrimination in larval gills is not typical of Zygoptera (R. Seidenbusch, personal communication, August, 2011). Other variations among the five exuviae were likely to be either natural or a result of the preservation method of the original female exuvia. The swelling of the first four abdominal segments and the extent of the mask are consistent with the effect of ethanol. The overall hairiness of the female exuvia from the original description was found to be less than the male exuvia, but this is unlikely to be attributable to intersexual differences because the second female exuvia had gills covered in a similar pattern as the males. While the ethanol could be responsible for the loss of hairs on some body parts, the shape of the gills seem well outlined and does not appear to be influenced by the preservation method. However, further material is needed to test the variations in the shape of the gills in *T. percostale*.

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